Title of the Invention

WIRELESS LAN ACCESS POINT APPARATUS

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WIRELESS LAN ACCESS POINT APPARATUS

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention generally relates to a wireless LAN (Local Area Network) system. More

5 particularly, the present invention is concerned with an access point apparatus for measuring or determining the current location or position of a mobile terminal in the wireless LAN system by making use of a radio signal. Incidentally, the access point apparatus may

10 also be referred to as the access point station or base station in more general terms.

DESCRIPTION OF THE RELATED ART

For better understanding of the concept underlying the present invention, description will

15 firstly be made of background techniques of the invention. As a method of measuring or determining the current location of a terminal with the aid of a radio signal used in the wireless LAN system, there can be mentioned a method which is disclosed in A. Ogino et

20 al's article "INTEGRATED WIRELESS LAN ACCESS SYSTEM, (1) STUDY ON LOCATION SYSTEM" in "The Collection of Lecture Drafts in the General Convention of The Institute of Electronics, Information and Communication Engineers in Japan (2003)", B-5-203, p.662. In the

following, description will be made of the

configuration and operation of the wireless LAN access

point apparatus (base station) disclosed in the Ogino

et al reference.

5   Figure 9 of the accompanying drawings is a

schematic diagram which shows, by way of example, a

configuration of a wireless LAN system equipped with a

terminal locating facility (i.e., function for

determining a location or position of a terminal). A

10   plurality of access point apparatuses or base stations

(e.g. three access point apparatuses 1, 2 and 3 in the

case of the LAN system illustrated in Fig. 9) are

connected to a server 6 by way of a network 5

constituted by a public network and a mobile

15   communication network. The terminal denoted by

reference numeral 4 performs transaction of information

or data with the server 6 through the medium of these

access point apparatuses or base stations.

        A processing flow for determining the

20   location of the terminal 4 in the LAN system shown in

Fig. 9 will be described below. The terminal 4

transmits or sends a radio signal. The access point

apparatuses or base stations 1, 2 and 3 receive the

radio signal to execute the signal processing which is

25   required for determining the location of the terminal.

In addition, each of the access point apparatuses 1 to

3 informs the server 6 of the result of the above-

mentioned signal processing as executed via the network

5. On the basis of the signal processing result received from the individual access point apparatuses or stations, the server 6 arithmetically determines the location of the terminal 4.

Figure 10 of the accompanying drawings is a block diagram showing generally a structure of a hitherto known or conventional access point apparatus for realizing the processing flow mentioned above. Referring to the figure, a signal receiving unit 101 is designed to perform a reception processing at a high/intermediate frequency corresponding to the radio signal received via an antenna 100, a demodulation processing of a base-band signal and an AD conversion (Analog to Digital conversion) to thereby generate a received signal.

On the other hand, a received signal memory control module 106 is so designed or programmed as to perform an access control for storing the received signal generated by the signal receiving unit 101 in a received signal memory 102 in response to a capture start command messaged from a terminal location determining signal processing module 103 via a signal line 104. In that case, the received signal memory control module 106 holds as a capture start timing the timing which is indicated by a clock 107 when storage of the received signal in the received signal memory 102 is started. In this conjunction, the clock 107 may be constituted, for example, by a counter which

operates under the timing of a clock signal used in the access point apparatus.

Next, referring to Figs. 11 and 12 of the accompanying drawings, description will turn to an

5　access control method carried out by the received signal memory control module 106 in the conventional access point apparatus or station. It is assumed that the storage of the received signal is started at a timing T_{p0} shown in Fig. 11. In that case, the received

10　signal memory control module 106 firstly stores the timing T_{p0} as the capture start timing. In addition, the received signal memory control module 106 stores the received signal at the timing T_{p0} in the received signal memory 102 at an address A_{p0}, as shown in Fig.

15　12. In this conjunction, the address A_{p0} may be a predetermined address or alternatively it may be designated by the terminal location determining signal processing module 103 upon issuance of the capture start command from the terminal location determining

20　signal processing module 103. In succession, the received signal memory control module 106 carries out the access control such that the received signal is stored sequentially in the received signal memory 102 at the addresses A_{p0+1}, A_{p0+2}, ... in this order, as is

25　illustrated in Fig. 12. When the received signal has been stored up to the address A_{p1} in the received signal memory 102, the received signal memory control module 106 terminates or ends the process of storing the

received signal in the received signal memory 102.
Incidentally, the address A_{p1} may be a predetermined
address or alternatively it may be designated by the
terminal location determining signal processing module
5   103 when the received signal capture start command is
issued by the terminal location determining signal
processing module 103.

Upon completion of the storage of the
received signal in the received signal memory 102, the
10 received signal memory control module 106 sends a
received signal capture end message and the capture
start timing to the terminal location determining
signal processing module 103 via a signal line 105.

Upon reception of the capture end message
15 mentioned above, the terminal location determining
signal processing module 103 executes the signal
processing required for arithmetically determining the
location of the mobile terminal on the basis of the
received signal stored in the received signal memory
20 and the capture start timing mentioned above, the
result of the signal processing being then messaged or
transferred to the server 6 shown in Fig. 9. As the
signal processing required for the arithmetic
determination of the location or position of the mobile
25 terminal, there can be mentioned a processing for
arithmetically determining the reception timing of the
signal sent from the terminal, a processing for
arithmetically determining a delay profile for the

determination of the reception timing, etc.. In this conjunction, it should be added that a matched filter, for example, may be employed for the arithmetic determination of the delay profile. Further, for

5   arithmetically deriving the reception timing of the received signal from the delay profile as obtained, a method disclosed in e.g. JP-A-2002-14152 may be adopted. Alternatively, the received signal stored in the received signal memory 102 may be intactly

10   transferred to the server 6 without executing any particular processing on the received signal stored in the received signal memory 102.

The server 6 then arithmetically determines the location or position of the terminal on the basis

15   of the results of the signal processings sent from the individual access point apparatuses (base stations) 1, 2 and 3 by resorting to, for example, a trilateration method described, for example, in the Ogino et al reference cited hereinbefore.

20   SUMMARY OF THE INVENTION

The wireless LAN system is a packet communication system. Consequently, a packet signal exists locally within a certain or given time zone and does not exist in the other time zone. Under the

25   circumstances, there may arise such situation that with the hitherto known or conventional access point apparatus such as described above, the packet signal

sent to the access point apparatuses from the terminal 4 for the location determination thereof can not be stored in the received signal memory 102. By way of example, in the case of a situation illustrated in

5 Figs. 13, the access point apparatus stores the received signal in the received signal memory 102 during a period or session extending from a point T_{p2} to a timing T_{p3}. However, a packet signal 200 sent from the terminal 4 exists within a time zone extending from

10 a timing T_{p4} to a timing T_{p5}. Consequently, the received signal containing the packet signal 200 can not be stored in the received signal memory 102. In general, in the packet communication, the delay time may remarkably vary in dependence on increase/decrease or

15 change of the traffic volume in the communication channel. For this reason, the situation in which the delay time of the packet increases will frequently take place, incurring such undesirable situation as illustrated in Fig. 13. In that case, the relevant

20 access point apparatus or station is incapable of sending to the server 6 the information useful for determination of the terminal location, as a result of which accuracy and reliability of the terminal locating arithmetic procedure executed by the server 6 will

25 suffer degradation.

For coping with the problem mentioned above, there may be conceived a method of storing in the received signal memory 102 the received signal of a

temporal duration lengthened to an extent sufficient
for absorbing the variation of the delay time of the
packet signal. By way of example, by capturing the
received signal over the period or session (from the
5   timing T_{p6} to T_{p7}) long enough to cover the variation of
the packet delay time, as is illustrated in Fig. 14,
the packet signal 200 (having a duration T_{p8} to T_{p9}) sent
from the terminal for determination of the location
thereof can be stored in the received signal memory
10   102. In this conjunction, the contents of the received
signal stored in the received signal memory 102 are
illustrated in Fig. 15. It can be seen that in the
received signal stored in the received signal memory
102, the packet signal 200 exists only in the memory
15   space delimited by the addresses A_{p8} and A_{p9} inclusive,
while in the other memory spaces (addresses A_{p6} to A_{p8-1}
and A_{p9+1} to A_{p7}), there exists no signals except noise
signals. The signal which can be used for
determination of the location of the terminal is only
20   the packet signal 200. Consequently, the memory space
in which the noise signals are stored can not
contribute to the location determination of the
terminal. This means that the utilization efficiency
of the received signal memory 102 is degraded. As a
25   consequence, the memory capacity demanded by the access
point apparatus or base station increases
correspondingly, which in turn incurs increase of the
cost involved in implementation and operation or

running of the access point apparatus, and hence cost
of the location information service provided by the
wireless LAN system will eventually increase, whereby
convenience of the location information service is

5 lowered.

The related art of the invention which has
been described by reference to Figs. 9 to 15, however
does not mean admission in the U.S. statute.

Thus, in light of the state of art described
10 above, an object of the present invention is to provide
an improved access point apparatus in which the
problems mentioned above are successfully and
satisfactorily solved.

In view of the above and other objects which
15 will become apparent as the description proceeds, there
is provided according to a general aspect of the
present invention an access point apparatus for a
terminal locating system for determining a location of
a terminal on the basis of a timing at which a radio
20 packet signal sent from the terminal is received.

The access point apparatus mentioned above
comprises a signal receiving unit for receiving the
radio packet signal to thereby generate a received
signal, a received signal memory for storing the
25 received signal, a packet detection module for
detecting a packet contained in the generated received
signal, a received signal memory control module for
performing a received signal write control for writing

the received signal in the received signal memory from
the signal receiving unit and a read control unit for
reading out the received signal from the received
signal memory, and a clock for correlating the received
5   signal and time in the access point apparatus.

The received signal memory control module is
so arranged as to perform such control that the
received signal is written in the received signal
memory sequentially from a first address and after
10   writing of the received signal in the received signal
memory at a second address, the received signal is
again written in the received signal memory
sequentially from the first address while writing of
the received signal in the received signal memory is
15   stopped in response to detection of a packet contained
in the received signal by the packet detecting module.

The reception timing of the radio packet
signal is determined on the basis of the received
signal readout and the time in the wireless LAN access
20   point apparatus.

With the arrangement of the access point
apparatus according to the present invention described
above, the received signal memory control module is so
designed as to control the access made to the access
25   point apparatus (base station) such that the memory
space can be reused by sequentially performing
overwrite operation on the received signal memory. In
addition, the received signal memory control module is

designed to stop capturing of the received signal in response to the packet detection signal issued by the packet detecting means.

The above and other objects, features and
5 attendant advantages of the present invention will more easily be understood by reading the following description of the preferred embodiments thereof taken, only by way of example, in conjunction with the accompanying drawings.

10 BRIEF DESCRIPTION OF THE DRAWINGS

In the course of the description which follows, reference is made to the drawings, in which:

Fig. 1 is a block diagram showing generally and schematically a circuit configuration of a wireless
15 LAN access point apparatus to which the present invention is applied;

Fig. 2 is a view for illustrating a method of accessing a received signal memory in the above-mentioned wireless LAN access point apparatus;

20 Fig. 3 is a view for illustrating a packet detection in a capture stop method according to a first embodiment of the present invention;

Fig. 4 is a view for illustrating a method of accessing a received signal memory in the capture stop
25 method according to the first embodiment of the present invention;

Fig. 5 is a view for illustrating a packet

detection in the capture stop method according to a second embodiment of the present invention;

Fig. 6 is a view for illustrating a method of accessing the received signal memory in the capture stop method according to the second embodiment of the present invention;

Fig. 7 is a view for illustrating a packet detection in the capture stop method according to a third embodiment of the present invention;

Fig. 8 is a view for illustrating a method of accessing the received signal memory in the capture stop method according to the third embodiment of the present invention;

Fig. 9 is an view for illustrating an example of a wireless LAN system equipped with a terminal location determining facility, to which the present invention is applied;

Fig. 10 is a block circuit diagram showing a conventional wireless LAN access point apparatus;

Fig. 11 is a view for illustrating a conventional received signal capturing method;

Fig. 12 is a view for illustrating a conventional method of accessing a received signal memory;

Fig. 13 is a view for illustrating a case where no packet exists in a capture session;

Fig. 14 is a view for illustrating a case where a packet exists within the capture session; and

Fig. 15 is a view for illustrating a state where the received signal memory is used in the conventional wireless LAN access point apparatus.

DETAILED DESCRIPTION OF THE EMBODIMENTS

5   The present invention will be described in detail in conjunction with what is presently considered as typical embodiments thereof by reference to the drawings.

       Figure 1 shows generally and schematically a

10 configuration of the access point apparatus (base station) to which the teachings of the present invention are applied. In the figure, components same as or equivalent to those described hereinbefore in conjunction with the conventional access point

15 apparatus are denoted by like reference numerals. At this juncture, it should be firstly be mentioned that implementation of the signal receiving unit in the access point apparatus or station is not always essential for the present invention. It is sufficient

20 for realization of the present invention that the terminal unit is so arranged as to make use of the reception timing of the down-link radio signal, as will become apparent as the description proceeds. Referring to Fig. 1, a signal receiving unit 101 performs a

25 reception processing at a high/intermediate frequency corresponding to the radio signal received via an antenna 100, a demodulation processing of a base-band

signal and an AD (Analog-to-Digital) conversion to thereby generate a received signal.

A received signal memory control module 120 starts to capture the received signal generated by the signal receiving unit 101 in a received signal memory 102 in response to a capture start command issued by a signal processing module for terminal location determination 103 and transmitted via a signal line 104. A method of writing the received signal in the received signal memory 102 by means of a received signal memory control module 120 is shown in Fig. 2. As can be seen from this figure, the received signal memory control module 120 firstly writes the received signal sequentially in a memory space extending from a leading write address A_0 to an address A_{N-1}. Upon completion of writing of the received signal up to the address A_{N-1}, the received signal memory control module 120 carries out an access control for the received signal memory 102 so that the succeeding received signal is written at the address A_0. The received signal memory control module 120 repeats the operation mentioned above. In this manner, the access control for the received signal memory 102 is executed such that the received signal is repetitionally written in the memory space extending from the address A_0 to the address A_{N-1}, as is illustrated in Fig. 2.

The received signal memory control module 120 stops the capture of the received signal in the

received signal memory 102 upon reception of a packet

detection signal issued by a packet detecting module

121. By virtue of this method, the packet can be

stored with high efficiency with a small memory

5   capacity independently of the length of the time period

during which the received signal is captured. Thus, so

far as the memory capacity is equivalent to at least

one packet or equivalent to the signal length required

for determining the reception timing of the packet, the

10 position or location of the terminal can be detected by

carrying out the packet communication according to the

method of the present invention. Even when the time

and margin involved in the packet detection processing

is taken into account, the memory capacity about twice

15 as large as that of the packet will be sufficient for

the determination of the terminal location.

Now referring to Figs. 3 and 4, description

will be directed to a method of stopping the capture of

the received signal through cooperation of the packet

20 detecting module 121 and the received signal memory

control module 120 according to a first embodiment of

the present invention. As shown in Fig. 3, the packet

detecting module 121 is designed to detect a leading

portion or edge of a packet signal 201 arrived at the

25 access point apparatus (base station) at a timing T_s and

message the detection of the packet head to the

received signal memory control module 120. For

detecting the leading edge of the packet signal, there

can be mentioned a method of making decision as to
whether or not the received power increases steeply
beyond a threshold value, to thereby determine the
detection of the leading edge of the packet signal when

5   the threshold value is exceeded. Alternatively, such a
detection method may equally be adopted according to
which a correlation value of the received signal and a
predetermined preamble pattern is arithmetically
determined by using e.g. a matched filter or the like

10   for thereby detecting a preamble affixed to the leading
of the packet signal. Upon reception of the message
informing the detection of the packet head from the
packet detecting module 121, the received signal memory
control module 120 stops capturing the received signal.

15   This operation will be elucidated below by reference to
Fig. 4. It is assumed that a received signal of the
leading edge (the timing T_s) of the packet signal 201
which is detected by the packet detecting module 121 is
written in the received signal memory 102 at an address

20   A_s, as shown in Fig. 4. In response to reception of the
message informing the detection of the packet head, the
received signal memory control module 120 executes
writing of the received signal up to an address A_{s-1} in
accordance with the access control method described

25   previously by reference to Fig. 2, whereupon capturing
of the received signal is terminated. Furthermore, the
received signal memory control module 120 records as a
packet head address the address A_s at which the received

signal is written at the timing when the message of
detection of the packet head is received from the
packet detecting module 121. Moreover, the received
signal memory control module 120 records as a packet

5 head timing the timing T_s indicated by the clock 107 at
the timing when the message of detection of the packet
head is received from the packet detecting module 121.
In this conjunction, it should also be added that the
received signal memory control module 120 may be so

10 arranged as to record instead of recording the timing T_s
a timing indicated by the clock 107 when capturing of
the received signal was started and a count value
resulting from counting the number of times the
received signal has been written at the address A_0

15 during the period or session from the start of
capturing the received signal to the end thereof.

Next, referring to Figs. 5 and 6, description
will be directed to the method of stopping the capture
of the received signal effected through cooperation of

20 the packet detecting module 121 and the received signal
memory control module 120 according to a second
embodiment of the present invention. As shown in Fig.
5, the packet detecting module 121 is designed to
detect a trailing portion or edge of a packet signal

25 202 arrived at the access point apparatus (base
station) and message the detection of the packet end to
the received signal memory control module 120. For
detecting the trailing edge of the packet signal, there

can be mentioned a method of making decision as to
whether or not the received power decreases steeply
below a threshold value, to thereby determine the
detection of the trailing edge of the packet signal

5 when the received power becomes lower than the
threshold value. Upon reception of the message
informing the detection of the packet end from the
packet detecting module 121, the received signal memory
control module 120 stops capturing the received signal.

10 This operation will be elucidated below by reference to
Fig. 6. The received signal memory control module 120
is so designed that when the received signal of the
trailing edge (timing T_E) of the packet signal 202 as
detected by the packet detecting module 121 is written

15 in the received signal memory 102 at an address A_E, as
shown in Fig. 6, capturing of the received signal is
immediately terminated. Furthermore, the received
signal memory control module 120 records as a packet
end address the address A_E at which the received signal

20 is written at the timing when the message of detection
of the packet end was received from the packet
detecting module 121. Moreover, the received signal
memory control module 120 records as a packet end
timing the timing T_E indicated by a clock 107 when the

25 message of detection of the packet end was received
from the packet detecting module 121. In this
conjunction, it should also be added that the received
signal memory control module 120 may be so arranged as

to record instead of the timing T_E a timing indicated by the clock 107 when capturing of the received signal was started and a count value resulting from counting the number of times the received signal has been written at

5   the address A_0 during the period or session the start of capturing the received signal to the end thereof.

Referring to Figs. 7 and 8, description will be directed to the method of stopping the capture of the received signal effected through cooperation of the

10   packet detecting module 121 and the received signal memory control module 120 according to a third embodiment of the present invention. Referring to Fig. 7, the packet detecting module 121 detects a packet signal 203 arrived at the access point apparatus (base

15   station) at an intermediate portion of the packet (timing T_p) and messages the detection of the packet to the received signal memory control module 120. For detecting the packet at the intermediate portion thereof, as mentioned above, there can be adopted, for

20   example, a method of monitoring the received signal power for a predetermined period and making decision as to whether or not a mean value of the received power exceeds a threshold value. When the mean value of the received power exceeds the threshold value, it can then

25   be decided that the packet signal has been detected. Upon reception of the message informing the detection of the packet signal from the packet detecting module 121, the received signal memory control module 120

stops capturing the received signal. This operation will be elucidated below by reference to Fig. 8. At this juncture, it is assumed that the received signal at the timing (T_p) at which the packet signal 203 was

5 detected by the packet detecting module 121 has been written in the received signal memory 102 at an address A_p, as shown in Fig. 8. In response to the message of the packet detection, the received signal memory control module 120 writes the received signal

10 additionally at L addresses in accordance with the access control method described hereinbefore by reference to Fig. 2, whereupon capture of the received signal comes to an end. Thus, the final address at which the received signal has been written is

15 represented by "mod (A_p+L, N)", where "mod (X, Y)" indicates a remainder resulting from division of "X" by "Y", and "N" represents the number of addresses existing in the memory space extending from the address A0 to the address A_{N-1}. Further, "L" represents a value

20 which can be determined in advance or alternatively the value contained in the capture start command issued by the location determining signal processing module 103. Further, the received signal memory control module 120 records as a packet detection address the address A_p at

25 which the received signal has been written when the message of packet detection was received from the packet detecting module 121. In addition, the received signal memory control module 120 records as a packet

detection timing the timing T_p indicated by the clock
107 when the message of the packet detection is
received from the packet detecting module 121.
Alternatively, the received signal memory control

5   module 120 may be so arranged as to record as a capture
end address the address "mod (A_p+L, N)" at the timing
when capturing of the received signal is terminated
while recording as a capture end timing the timing T_{CE}
indicated by the clock 107 when capturing of the

10   received signal is stopped. In this conjunction, it
should also be mentioned that the received signal
memory control module 120 may be so arranged as to
record instead of recording the timings T_P and T_{CE}
mentioned above the timing indicated by the clock 107

15   when capturing of the received signal was started and a
count value resulting from counting the number of times
the received signal has been written at the address A_0
during the period or session extending from the start
of capturing the received signal to the end thereof.

20   Upon completion of capturing the received
signal in the received signal memory 102, the received
signal memory control module 120 issues to the terminal
location determining signal processing module 103 via
the signal line 105 a message of completion of the

25   received signal capturing as well as the timings
indicated by the clock 107 and the addresses of the
received signal memory 102 as recorded in the course of
execution of the received signal capture stopping

method described above.

In response to reception of the capture end
message mentioned above, the terminal location
determining signal processing module 103 reads out
5   sequentially the received signals from the received
signal memory 102, starting from the temporally
earliest received signal.

More specifically, when the capture stopping
method according to the first embodiment of the present
10   invention is adopted, the terminal location determining
signal processing module 103 reads out the received
signal from the received signal memory 102, starting
from the packet head address A_S informed when the
capture end message is sent from the received signal
15   memory control module 120 up to the address A_{S-1} in
accordance with the access control method illustrated
in Fig. 2.

on the other hand, when the capture stopping
method according to the second embodiment of the
20   present invention is adopted, the terminal location
determining signal processing module 103 reads out the
received signal from the received signal memory 102,
starting from an address A_{E+1} which succeeds to the
packet end address A_E informed upon reception of the
25   capture end message from the received signal memory
control module 120 up to the address A_E in accordance
with the assess control method described hereinbefore
by reference to Fig. 2.

Furthermore, when the capture stopping method according to the third embodiment of the present invention is adopted, the terminal location determining signal processing module 103 arithmetically determines

5   at first the address "mod (A_p+L, N)" written upon completion of the received signal capturing on the basis of the packet detection address A_p informed by the capture end message from the received signal memory control module 120. Alternatively, in the case where

10 the capture end address "mod (A_p+L, N)" is informed in the capture stopping method according to the third embodiment of the present invention, this address may be used intactly as the write address at the end of the capturing process. In succession, the terminal

15 location determining signal processing module 103 reads out the received signal, starting from the address which succeeds to the write address at the end of the capturing process, i.e., the address "mod $(A_p+L, N)+1$", up to the address "mod (A_p+L, N)" in accordance with the

20 access control method described hereinbefore in conjunction with Fig. 2.

After having read out the received signal by resorting to the method described above, the terminal location determining signal processing module 103

25 executes the signal processing required for arithmetically determining the position or location of the mobile terminal as in the case of the conventional access point apparatus (base station) described

hereinbefore, the result of which is transferred to the

server 6 shown in Fig. 9. At this juncture, it should

be noted that the signal processing mentioned above is

executed by using the timings at which the leading and

5 trailing edges of the packet were detected or

alternatively the timing at which the packet being

received was detected. As the signal processing

required for the terminal locating arithmetic, there

can be mentioned arithmetical determination of the

10 timing at which the signal from the terminal was

received or the delay profile for computing the

reception timing or the like. For the arithmetic

determination of the delay profile, the matched filter,

for example, may be employed. Furthermore, for

15 arithmetically determining or computing the reception

timing of the received signal on the basis of the delay

profile as acquired, there may be adopted a method

disclosed in e.g. JP-A-2002-14152. Alternatively, the

stored received signal may be intactly transferred to

20 the server 6 without executing any particular

processing on the received signal held in the received

signal memory 102.

The server 6 arithmetically determines the

position or location of the terminal in accordance with

25 a method similar to that mentioned hereinbefore in

conjunction with the background techniques.

Alternatively, capturing of the packet may be

stopped after lapse of a predetermined time since the

timing at which the packet was detected. By way of
example, in the case of the first embodiment of the
present invention, the packet capture may be carried
out till the time taken for receiving one packet after
5   detection of the packet has elapsed. Further, in the
case of the second embodiment of the present invention,
the packet capturing may be carried out until the time
determined by subtracting the time period for averaging
the received power from the time taken for receiving
10 one packet has elapsed after the packet detection.

Owing to the teachings of the present
invention described above, the memory capacity packaged
in the access point apparatus (base station) for
capturing the received signal can be reduced, which of
15 course leads to cost reduction of the access point
apparatus and hence to reduction of cost involved in
the location information service provided by the
wireless LAN system while enhancing the serviceableness
and probitability thereof.

20   An example of the memory capacity reduction
will be described below in the concrete.

By way of example, let's consider detection
of the location of a terminal in a system implemented
in conformance with the Wireless LAN Standards
25 IEEE802.11b. According to the Standards IEEE802.11b,
each of the individual packets ordinarily has a length
or duration on the order of 0.2 msec. to 19 msec. in
dependence on the amount of data and the transmission

rate. When the packet of about 1 msec. is employed for locating the terminal (i.e., for determining the position or location of the terminal), the packet mentioned above corresponds to the memory capacity of

5   0.7 Mbits on the assumption that the sampling frequency is e.g. 44 MHz and that the bit width of in-phase component and quadrature component, respectively, is e.g. 8 bits.

In the case where the location detection is
10 performed by using the above-mentioned packet, the memory employed in the conventional access point apparatus (base station) for capturing the received signal is required to have the capacity capable of storing the received signal at least for a session of
15 about 200 msec. in consideration of the time taken for the communication between the server and the access point apparatus as well as the communication between the access point apparatus and the terminal and additionally the delay time of the packet which depends
20 on the traffic volume on the network. On the above assumption that the sampling frequency is e.g. 44 MHz and that the bit width of in-phase component and quadrature component, respectively, is e.g. 8 bits, the packet mentioned above corresponds to the memory
25 capacity of 140 Mbits.

By contrast, in the case of the access point apparatus (base station) implemented in accordance with the teachings of the present invention, it is

sufficient that the memory for capturing the received signal has a capacity capable of storing the received signal of the duration twice as long as the packet length or 2 msec. at maximum, which means that the

5 memory capacity is 1.4 Mbits on the sampling conditions mentioned above. The reason why the capacity exceeds the packet length can be explained by the fact that the response performance and margin involved in the packet detection has to be taken into account. It is thus

10 apparent that according to the teachings of the present invention, the capacity of the memory for capturing the received signal in the access point apparatus can be reduced by a factor of 1/100 or so when compared with the hitherto known access point apparatus.

15   It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without

20 departing from the spirit of the invention and the scope of the appended claims.